Bulgarian Journal of Agricultural Science, 15 (No 5) 2009, 417-422
Agricultural Academy

INTERACTION OF THE TECHNOLOGICAL PROPERTIES OF COMMON WINTER WHEAT VARIETIES WITH SOME AGRONOMY FACTORS

I. STOEVA and A. IVANOVA
Dobrudzha Agricultural Institute, BG-9520 General Toshevo, Bulgaria

Abstract

STOEVA, I. and A. IVANOVA, 2009. Interaction of the technological properties of common winter wheat varieties with some agronomy factors. *Bulg. J. Agric. Sci.,* 15: 417-422

This paper presents results obtained during the period 2004 – 2006 on the changes of wet gluten content in flour, the sedimentation value, the physical properties of dough and the bread-making quality of varieties Aglika, Iveta, Pryaspa, Kristi and Karat (these varieties being from different quality groups) according to the main elements of the agronomy practice: crop rotation and the norm of mineral fertilization.

It was found that the phenotype variations in the sedimentation value and wet gluten content in 70 % flour of the varieties were determined by the fertilization applied and the year conditions.

The variations in the valorimeric value and bread loaf resulted from the variety x fertilization x year interaction. The effect of crop rotation was not significant. Variety Aglika had the best quality indices combined with high responsiveness to improved environmental conditions. Variety Kristi (of medium strength) demonstrated the best ecological stability with regard to physical properties of dough and bread loaf.

Key words: wheat, variety, quality, agronomy practice

Introduction

Grain quality and quantity are formed during the entire vegetation period; they are the function of the genetic potential of the variety, the agro-ecological conditions and the technology of cultivation (Shtereva, 1988; Panayotova, 1998; Tsenov et al., 2004). Among all technology elements, fertilization has the highest effect (Koteva and Stoeva, 1996). The role of the agronomy practice and the meteorological conditions in the realization of the genetic potential for productivity and grain quality of the different varieties has been subjected to many investigations of various duration (Varlev, 1983; Petrova, 1984; Filipov, 1995; Gospodinov et al., 1999; Koteva et al., 2005; Stoeva et al., 2006).

Grain quality can be improved through both breeding and agronomy practice methods. The breeding methods contribute to the accumulation of permanent and variable favorable properties, and the agronomy practice is requisite for fast effects and for higher flexibility under various conditions. The recent breeding achievements open wide possibilities for management of the wheat grain technological properties towards

e-mail: albivanova@abv.bg

changing the respective agronomy practice means. Their effect is specific with regard to the variety and the growing conditions and has been subjected to many investigations of various duration (Koteva et al., 1996; Nikolova et al., 1995; Rachovsky, 2005; Filipov, 1995; Tsankova, 1997).

The aim of this investigation was to test a group of varieties under a combination of controlled agronomy factors and to obtain more detailed information on their quality potential under the specific environment of DAI – General Toshevo.

Material and Methods

The experimental work was carried out during the period 2004 – 2006 and was performed by the split plot method on a harvest area of 22.5 m^2 in 4 replicates. The varieties Aglika, Iveta, Pryaspa, Kristi and Karat (from different quality groups) were grown under field conditions after three previous crops: bean, sunflower and grain maize. Fertilization was applied according to the type of previous crop: $N_0P_0K_0$ and $N_6P_6K_0$ after bean, and $N_0P_0K_0$ and $N_{10}P_{10}K_0$ after sunflower and grain maize. Soil preparation included single disking after harvesting of the previous crops and double disking after the main fertilization. Fertilization was performed manually, applying phosphorus before the main tillage, and nitrogen – before permanent spring vegetation. The fertilizers used were triple superphosphate and ammonium saltpetre nitre. Sowing was done with 500 germinating seeds per m^2 within the optimal sowing term for this region.

The mean grain samples from the variants were ground to 70 % flour with milling equipment MLU-202. The following indices were analyzed: sedimentation value (Pumpyanskiy, 1971); wet gluten yield in 70% flour (Bulgarian State Standard 13375-88), valorimeric value by pharinograph (Brabender) and bread loaf (according to the methodology adopted at the Bread making quality Laboratory in DAI). The individual statistical parameters were determined by Microsoft Excel 2002 and the package SPSS 13.

During the investigated years the meteorological conditions were rather variable. For that period the mean annual precipitation sums which form the autumn-and-winter moisture reserves in soil (October – March), and of the precipitation sums during grain filling – maturation (June – July) were higher that the mean precipitation values for the long-term period (1952 - 2006). The period April-May of 2005 (booting-heading stage) was an exception; the mean annual precipitation sum was with 26.3 mm lower than the mean value for the long-term period. The temperatures did not differ dramatically from the temperatures typical for the 53-year period. The spring-and-summer season of 2004 was however more specific: there was extreme drought in April (2.2 mm) and abundant rainfalls in May (93.7 mm), June (71.2 mm) and July (84.6 mm). The second year from the investigation was characterized with higher parameters of the mean temperatures in comparison to the long-term period values, with a dry autumn and a humid winter. April was a dry month similar to the previous year, and the air temperatures and soil moisture during May and June were close to the values typical for the region. The meteorological conditions during 2005-2006 were characterized with a humid autumn, cold winter and warm spring. The air temperatures were close to the norm. The maximum amount of rainfalls was registered in May (94.4 mm), the season was favourable for yield realization and partially restrictive for the expression of the varieties' quality potential.

Results and Discussion

The dispersion analysis revealed significant variations among the varieties by most of the investigated indices (Table 1). The phenotype variations in the sedimentation value and the wet gluten in flour were markedly dependent on the year conditions (D), while fertilization (C) contributed more to the deviations from the pharinographic values and bread loaf. The effect of the previous crop (B) on the expression of the investigated indices was not significant. The significant variations in the valorimeric value and the bread loaf of the varieties were conditioned by the interaction between the three factors: variety (A) x fertilization (C) x year (D). This allowed following their variability

Table 1

Dispersion analysis of important technological indices according to the agronomy practices during the period 2004 – 2006

Indices / Sources of variation	df	Sedimentation value, ml		Wet gluten yield in 70% flour, %		Valorimeric value, condit. units		Bread loaf, ml	
		F	Sig.	F	Sig.	F	Sig.	F	Sig.
Variety (A)	4	130.5	0	0.13	0.73	29.55	0	41.93	0
Previouscrop(B)	1	0.9	0.51	1.11	0.42	2.67	0.09	2.1	0.17
Fertilization (C)	1	0.57	0.59	6.71	0.02	2.02	0.18	0.28	0.96
Year (D)	2	0.61	0.75	0.2	0.83	8.89	0	2.48	0.15
A x B	4	36.19	0	62.34	0	1.26	0.36	0.58	0.69
A x C	4	2.05	0.16	1.84	0.21	0.62	0.56	8.45	0.01
A x D	8	0.65	0.64	0.61	0.75	1.39	0.32	1.21	0.35
B x C	1	215.54	0	3.33	0.11	115.69	0	100.35	0
B x D	2	1.16	0.4	16.28	0	16.85	0	0	0.95
C x D	2	1.31	0.32	68.45	0	1.54	0.28	1.5	0.29
A x B x C	4	12.2	0	2.33	0.16	69.64	0	0.2	0.66
A x B x D	8	89.53	0	33.23	0	3.58	0.06	14.17	0
A x C x D	8	21.16	0	0.2	0.66	4.86	0.04	51.28	0
B x C x D	2	3.47	0.06	0.97	0.52	4.66	0.02	0.13	0.88

according to fertilization, averaged for the period 2004 – 2006.

The variation dynamics of the valorimeric value was strongly influenced by the specificity of the variety and by the fertilization during the investigated period. Highest mean values of the dough physical indices at fertilization with N_0P_0 were demonstrated by variety Aglika, and lowest – by variety Karat (Table 2). The arrangement of varieties remained the same, but the values of the index were higher.

The total effect from fertilization ($N_{10}P_{10}$) was manifested mainly through the more favourable conditions for expression of the index according to N_0P_0; it was highest in variety Aglika (Vc = 28.3%; b = 2.49; S2b = 21.29), followed by variety Iveta (Vc = 14.2%; b = 1.06; S2b = 6.20) and lowest in variety Karat (Vc = 7.6%; b = 0.25; S2b = 7.37). Year 2004 was most favorable with regard to the climatic conditions and the sedimentation value, the wet gluten content in 70% flour and the valorimeric value were best expressed; in this year the upper limit of the varieties' valorimeric value met the BSS requirements. The lower values of the index, especially in 2006, resulted from the negative effect of the climatic conditions during grain filling and maturation. The rheological properties of dough of variety Kristi at fertilization norm $N_{10}P_{10}$ resulted from the combination of low variability and comparatively good stability, while in variety Pryaspa the low mean valorimeric value was related to low responsiveness to fertilization and to high instability under the above conditions (b = 0.48; S2b = 20.34).

Variety Aglika demonstrated high responsiveness and phenotype instability under both ways of cultivation by bread loaf. Fertilization in varieties Iveta and Kristi revealed a tendency towards lower changes in the relatively higher values of bread loaf in comparison to the variant with N_0P_0 fertilization. It is evident that the character of combination of different types and fertilization norms had significant effect on their interaction within a wide range: from strong effect on the valorimeric value and bread loaf (variety Aglika)

Table 2
Variability and stability of the investigated varieties by valorimeric value and bread loaf according to fertilization during the period 2004-2006

Variety	Fertilization norm							
	N_0P_0				$N_{10}P_{10}$			
	$\overline{X}$	Vc	b	S2b	$\overline{X}$	Vc	b	S2b
Valorimeric value, conditional units								
Aglika	51	6.6	1.58+	1.83	65	28.3	2.49+	21.29
Iveta	49	5.3	0.84	5.1	56	14.2	1.06+	6.2
Pryaspa	39	7.5	0.51	9.53	39	13.6	0.48	20.34
Kristi	41	9.7	1.64+	5.96	45	12.5	0.73+	4.98
Karat	36	4.2	0.42	1.81	40	7.6	0.25	7.37
Bread loaf, ml								
Aglika	651	8.2	1.62+	347.77	743	5.9	1.17	1076
Iveta	648	10.5	2.08+	474.87	695	4.5	0.58	897.68
Pryaspa	641	2.1	-0.18	190.22	643	8.2	1.63	2100.16
Kristi	661	7.1	1.18	1056.81	690	3.2	0.53	332.62
Karat	588	8.9	0.3	3347.83	609	8.2	1.55+	707.51

Key: $\overline{X}$- mean value; Vc - variation coefficient; b ‡ 1 - palsticity; S2b ‡ stability, significance: P = 5.0%

to the total lack of effect in variety Kristi ($N_{10}P_{10}$). Variety Karat (a low-quality variety) possesses high ecological plasticity (b>1) and instability of bread loaf, but it is still preferred for growing because of its high productivity. The rest of the varieties included in this investigation (Aglika, Iveta and Pryaspa), which combine yield and quality to various degrees, are widely used in mass production and can improve their bread loaf against high agronomy background, but they loose a lot of their ecological stability because they maintain higher yield level in unlimited environments (Ivanova, 2007). Concerning valorimeric value and bread loaf, variety Kristi has the potential to reach high values at N_0P_0; these values however sharply decreased under unfavourable conditions. At fertilization with $N_{10}P_{10}$ the variety had a weak response but its stability was markedly better, which makes it an intensive type variety.

The results obtained showed that purposeful growing of high quality varieties (Aglika, $N_{10}P_{10}$) lead to increased values of their technologically important indices (wet gluten content in 70% flour, sedimentation, valorimeric value, bread loaf) according to N_0P_0 although it did not improve the bread making properties of the weak wheat varieties (Karat). Varieties Iveta, Pryaspa and Kristi were of intermediate type since they responded with positive or negative changes of their valorimeric values and bread loaf at fertilization with $N_{10}P_{10}$ depending on the year conditions. This may be due to the damages caused by stink bug (Eurogaster integriceps Put.) or disturbed balance of nutrients during grain filling and maturation (Gotsova et al., 1988). Each specific case is the result from the complex interaction between the variety and the growing conditions.

Within this trail there was a strong positive correlation between the mean brad loaf from all variants, years and varieties, and the mean values of the rest of the indices (r>0.900), with the exception of the value of wet gluten content in 70% flour (r = 0.224) (Table 3). The correlation between bread loaf at N0P0 and the remaining indices varied from r = 0.308 with wet gluten in 70 % flour to r = 0.798 with bread loaf at $N_{10}P_{10}$. The correlation coefficients between bread

Table 3
Correlation coefficients between some important technological indices of flour

Indices	1	2	3	4	5	6
1. Mean bread loaf, ml						
2. Mean bread loaf, N_0P_0	0.912+					
3. Mean bread loaf, $N_{10}P_{10}$	0.975++	0.798				
4. Sedimentation, ml	0.898+	0.755	0.909+			
5. Wet gluten in 70% flour, %	0.224	0.308	0.159	0.548		
6. Dough resistance, min	0.727	0.422	0.84	0.887+	0.332	
7. Valorimeric value, cond. Un.	0.829	0.554	0.919+	0.910+	0.256	0.979++

Key: + significance at P = 5.0%; ++ significance at P = 1.0%

loaf at $N_{10}P_{10}$ and the sedimentation and rheological properties of dough were high (r>0.900), and with wet gluten in 70% flour they were low (r = 0.159). Low correlations were found between wet gluten content in 70% flour and the physical properties of dough (r<0.332). To break and improve to some extend the above correlations and to obtain quality with desired correlations further investigations will be needed on the stability level of the environmental factors.

Varieties Aglika, Iveta and Kristi are definitely suitable for intensive agriculture due to their very good bread making properties.

The agronomy practices used (fertilization and crop rotation in particular) had a positive effect on flour quality. Their action was specific with regard to the variety and the climatic conditions and their proper application contributed to the processes of grain quality management.

Conclusions

The investigated wheat varieties (Aglika, Iveta, Pryaspa, Kristy and Karat) demonstrated different realization of their quality potential under fertilization and crop rotation. The variations in valorimeric value and bread loaf resulted from the variety x fertilization x year interaction.

The fertilization factor had a stable effect on the sedimentation of varieties Aglika and Iveta, on the wet gluten content in 70% flour of varieties Aglika, Iveta, Pryaspa and Karat, on the rheological properties of dough of varieties Aglika, Iveta, Pryaspa, and especially on the bread loaf of variety Aglika. Variety Aglika had the best quality characteristics combined with high responsiveness to improved environmental conditions. Variety Kristi showed the best ecological stability of physical properties of dough and bread loaf.

References

Delchev, G., 2005. Interaction between nitrogen fertilization and extra-root nutrition and their effect on durum wheat grain quality and yield. Jubilee conference on Current state and problems of agrarian science and education, Agrarian University – Plovdiv, Proceedings, vol. I, 4: 67-72 (Bg).

Filipov, H., 1995. Nitrogen nutrition of wheat under highly variable hydro-thermal conditions and parameters of nitrogen in soil and plants. D. Sci. Dissertation, S., AA. (Bg).

Gospodinov, M., T. Tonev, M. Nankova, P. Ivanov and I. Ivanova, 1999. Effect of long-term mineral fertilization on wheat grain protein quality. I. Parameters of wheat productivity. UBS – Dobrich, 1: 81-86 (Bg).

Gotsova, V. and Ts. Rachinska, 1988. Heritability potential of intensive wheat varieties by grain quality and its realization. *Plant Sciences*, (7): 3-11 (Bg).

Ivanova A., 2007. Genotype specificity of nutrients uptake in common wheat (Tr. aestivum L.). Ph. D.

Thesis.

Koteva, V. and I. Stoeva, 1996. Effect of fertilization on the quality of wheat variety Sadovo 1 grown on leached smolnitza soil type in south-east Bulgaria. *Plant Sciences*, (2): 9-12 (Bg).

Koteva, V., P. Atanasov and S. Zapryanov, 2005. Investigation on the yield stability of wheat variety Miryana grown under different fertilization levels. *Balkan Scientific* Conference, Karnobat, **vol. II**: 443-447.

Nikolova, L. and D. Dimitrov, 1995. Effect of systematic mineral fertilization on the bread making quality of common winter wheat variety Katya. Jubilee scientific international Conference on the 90th Anniversary of Obraztsov Chiflik Institute – Rousse, **vol. II**: 47-52 (Bg).

Panayotova, G., 1998. Mineral fertilization of durum wheat grown in crop rotation with cotton, Ph. D. Thesis, Sofia. (Bg).

Petrova, M., 1984. Optimizing wheat fertilization grown on leached chernozem soil type, Sofia (Bg).

Pumpyanskiy, A. Y., 1971. Technological Properties of Common Wheat. l. P. 22 (Ru).

Rachovsky, G., 2005. Uptake of macro elements for yield formation in common winter wheat depending on the genotype. Jubilee conference on Current state and problems of agrarian science and education, Agrarian University – Plovdiv, Proceedings**, vol. I**, 4: 241-246 (Bg).

Shtereva, L., V. Gotsova and I. Stoeva, 1988. Self-compatibility and quality of some wheat varieties. *Plant Sciences*, (4): 5-9 (Bg).

Stoeva, I, N. Tsenov and E. Penchev 2006. Effect of environment on the quality of common winter wheat varieties. Field Crop Studies, 3 (1): 7-19 (Bg).

Tsankova, G., 1997. Nitrogen fertilization in the maize-wheat crop rotation element using hybrids with different vegetation periods, Ph. D. Thesis, Sofia. AA. (Bg).

Tsenov, N., K. Kostov, T. Gubatov and V. Peeva, 2004. Investigation on the genotype x environment interaction in winter wheat varieties. I. Grain quality. Field Crops studies, 1 (1): 20-29 (Bg).

Varlev, I., B. Simeonov and P. Gizdova, 1983. Effect of some climatic factors on wheat yield. *Plant Sciences*, (7): 5-13 (Bg).

Received June, 2, 2009; accepted for printing September, 13, 2009.